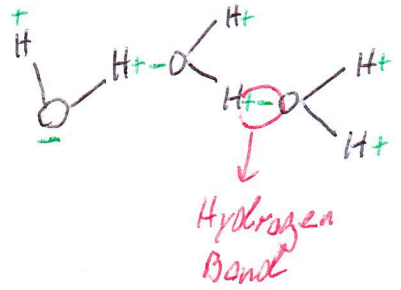
Name Key +54 Date

AP: CHAPTER 3

WATER AND THE FITNESS OF THE ENVIRONMENT

+3 1. Sketch a few molecules of water, indicate their polarity, and where the H bonds form.



+1 2. Why is H bonding so important to water's properties?

Hydrogen bonds are weak bonds allowing water molecules to constantly break + reform new bonds

3. List the "special" properties of water and give an example of why the property may be important to living things.

+2 a. Cohesion → Cohesion allows water molecules to bind together which allows water molecules to travel against gravity in plants

+2 b. Moderation of Temp → Waters high specific heat allows water to absorb + release large amounts of heat before changing structure allowing for a relatively constant env for living organisms

+2 c. Insulation of bodies of water by floating ice → Since water is less dense as a solid it will float to the surface when frozen insulating deeper waters allowing it to remain liquid and thus allowing life to continue

+2 d. The Solvent of life → waters ability to dissolve many substances without destroying the substance makes water a great transport mechanism.

+3 4. Place the appropriate letter next to each statement.

A—acids B—bases

+½ a. B They take up hydrogen ions in solution.

+½ b. A HCl is and example.

+½ c. B NaOH is an example.

+½ d. A They release hydrogen ions in solution.

+½ e. A They lower the pH

+½ f. B They raise the pH

+3 5. Complete the table for the following hydrogen ion concentrations $[H^+]$:

pH Scale based on $[H^+]$

$[H^+]$	pH	Acid/Base/Neutral
1×10^{-7} $[OH^-]=-7$	7	Neutral
1×10^{-3} $[OH^-]=-11$	3	Acid
1×10^{-8} $[OH^-]=-6$	8	Base

+2 6. Distinguish between hydrophilic and hydrophobic molecules?

Hydrophilic Molecules have an affinity to water

Hydrophobic molecules do not have an affinity for water

7. Explain the pH scale. +2

the pH scale is the measure of $[H^+]$ in a solution equal to $-\text{Log}[H^+]$ and ranges from 0-14. A number lower than 7 is acidic & higher than 7 is Basic

+4 8. What is a buffer? How do they work? Why are they necessary in biological systems? Give an example.

Buffers minimizes changes in the concentrations of H^+ & OH^-

Buffers work by accepting H^+ when in excess & donating H^+ when depleted

They are necessary to maintain a constent env.

Carbonic Acid helps maintain blood pH

+2 9. Indicate whether these statements are true (T) or false (F):

+½ a. F If the pH of blood changes from 7.4 to 7.6, it becomes more acidic.

+½ b. T When an acid is added to a solution , the pH decreases.

+½ c. T A basic pH indicates that OH^- ions outnumber H^+ ions.

+½ d. T An acidic pH indicates the H^+ ions outnumber OH^- ions.

10. The following questions relate to buffers:

+2 a. How do living things prevent drastic changes in pH?

The pH is stablized through the action of buffers, chemicals, or combinations of chemicals that take up excess H^+ or OH^- to keep the pH steady

+½ b. Complete the following reaction, showing how the carbonic acid buffer system deals with increasing hydrogen ions in the blood:

$H^+ + HCO_3^- \rightarrow$ H_2CO_3

+½ c. Complete the following reaction, showing how the carbonic acid buffer system deals with decreasing hydrogen ions in the blood:

$H_2CO_3 \rightarrow$ $H^+ + HCO_3^-$

11. Life as we know it could not exist without water. All the chemical reactions of life occur in aqueous solution. Water molecules are polar and are capable of forming hydrogen bonds with other polar or charged molecules. As a result, water has the following properties:

A. H_2O molecules are cohesive; they form hydrogen bonds with each other.
B. H_2O molecules are adhesive; they form hydrogen bonds with polar surfaces.
C. Water is a liquid at normal physiological (or body) temperatures.
D. Water has a high specific heat.
E. Water has a high heat of vaporization.
F. Water's greatest density occurs at 4° C.

Explain how these properties of water are related to the phenomena described in parts a-f below. More than one property may be used to explain a given phenomenon.

+2 a. During the winter, air temperatures in the northern United States can remain below 0°C for months; however, the fish and other animals living in lakes survive.

Water at 0°C will freeze causing it to become less dense and thus float to the surface of the lake. At the same time water that is above 0°C will sink below the ice. As a result the ice at the surface insulates the deeper waters preventing it from freezing allowing animals to survive

+2 b. Many substances— for example, salt (NaCl) and sucrose— dissolve quickly in water.

Water is a very polar molecule that has a high affinity for the Na^+ & Cl^- ions causing NaCl to dissociate and interact with water (dissolve)

+2 c. When you pour water into a 25-mL graduated cylinder, a meniscus forms at the top of the water column.

Water molecules are attracted to the polar molecules of the cylinder causing the water to move up the sides of the cylinder & thus pulling the other water molecules with it

+2 d. Sweating and the evaporation of sweat from the body surface help reduce a human's body temparature.

Water's heat of evaporation is 580 cal/g/°C which means that when water evaporates from the body it carries with it a large amount of heat

+2 e. Water drops that fall on a surface tend to form rounded drops or beads.

Water molecules are cohesive & form hydrogen bonds with each other. As a result, water molecules bead.

+2 f. If you touch the edge of a paper towel to a drop of colored water, the water will move up into (or be absorbed by) the towel.

The polar water molecules adhere to the cellulose in the paper towel & cohere to each other drawing them up into the paper towel.

Select the best answer.

+½ C 12. Each water molecule is capable of forming
a. one hydrogen bond.
b. three hydrogen bonds.
c. four hydrogen bonds.
d. two covalent bonds and two hydrogen bonds. e. two ionic bonds and two hydrogen bonds.

+½ A 13. The polarity of water molecules
a. promotes the formation of hydrogen bonds.
b. helps water to dissolve nonpolar solutes.
c. lowers the heat of vaporization and leads to evaporative cooling.
d. creates a crystalline structure in liquid water. e. does all of the above.

+½ E 14. What accounts for the movement of water up the veins of a tall tree?
a. cohesion
b. hydrogen bonding
c. adhesion
d. hydrophilic cell walls
e. all of the above

+½ E 15. Climates tend to be moderate near large bodies of water because
a. a large amount of solar heat is absorbed during the gradual rise in temperature of the water.
b. water releases heat to the environment as it cools.
c. the high specific heat of water helps to moderate air temperatures.
d. a great deal of heat is absorbed and released as hydrogen bonds break or form.
e. of all of the above.

+½ B 16. Temperature is a measure of
a. specific heat.
b. average kinetic energy of molecules.
c. total kinetic energy of molecules.
d. Celsius degrees.
e. joules.

+½ D 17. Evaporative cooling is a result of
a. a low heat of vaporization.
b. the release of heat during the breaking of hydrogen bonds when water molecules escape.
c. the absorption of heat as hydrogen bonds break.
d. the reduction in the average kinetic energy of a liquid after energetic water molecules enter the gaseous state.
e. both a and b.

+½ E 18. Ice floats because
a. air is trapped in the crystalline lattice.
b. the formation of hydrogen bonds releases heat; warmer objects float.
c. it has a smaller surface area than liquid water.
d. it insulates bodies of water so they do not freeze from the bottom up.
e. hydrogen bonding spaces the molecules farther apart, creating a less dense structure.

+½ B 19. The molarity of a solution is equal to
a. Avogadro's number of molecules in 1 liter of solvent.
b. the number of moles of a solute in 1 liter of solution.
c. the molecular mass of a solute in 1 liter of solution.
d. the number of solute molecules in 1 liter of solvent.
e. 342 g if the solute is sucrose.

+½ E 20. Some archaea are able to live in lakes with pH values of 11. How does pH 11 compare with the pH 7 typical of your body cells?
a. It is four times more acidic than pH 7.
b. It is four times more basic than pH 7.
c. It is a thousand times more acidic than pH 7.
d. It is a thousand times more basic than pH 7.
e. It is ten thousand times more basic than pH 7.

+½ D 21. A buffer
a. changes pH by a magnitude of 10.
b. releases excess OH-.
c. releases excess H+.
d. is often a weak acid-base pair.
e. always maintains a neutral pH.

+½ B 22. Which of the following is least soluble in water?
a. polar molecules
b. nonpolar molecules
c. ionic compounds
d. hydrophilic molecules
e. anions

+½ D 23. Which would be the best method for reducing acid precipitation?
a. Raise the height of smokestacks so that exhaust enters the upper atmosphere.
b. Add buffers and bases to bodies of water whose pH has dropped.
c. Use coal-burning generators rather than nuclear power to produce electricity.
d. Tighten emission control standards for factories and automobiles.
e. Reduce the concentration of heavy metals in industrial exhaust.

+½ C 24. What bonds must be broken for water to vaporize?
a. polar covalent bonds
b. nonpolar covalent bonds
c. hydrogen bonds
d. ionic bonds
e. polar covalent and hydrogen bonds

+½ C 25. How would you make a 0.1 M solution of glucose (C6H1206)? The mass numbers for these elements are approximately: C = 12,0 = 16, H = 1.
a. Mix 6 g C, 12 g H, and 6 g 0 in 1 liter of water.
b. Mix 72 g C, 12 g H, and 96 g 0 in 1 liter of water.
c. Mix 18 g of glucose with enough water to yield 1 liter of solution.
d. Mix 29 g of glucose with enough water to yield 1 liter of solution.
e. Mix 180 g of glucose with enough water to yield 1 liter of solution.

+½ E 26. How many molecules of glucose would be in the 1 liter 0.1 M solution made in question 14?
a. 0.1 c. 60 e. 6 X 1022
b. 6 d. 6 X 1023

+½ A 27. Why is water such an excellent solvent?
a. As a polar molecule, it can surround and dissolve ionic and polar molecules.
b. It forms ionic bonds with ions, hydrogen bonds with polar molecules, and hydrophobic interactions with nonpolar molecules.
c. It forms hydrogen bonds with itself.
d. It has a high specific heat and a high heat of vaporization.
e. It is wet and has a great deal of surface tension.

+½ B 28. Which of the following, when mixed with water, would form a colloid?
a. a large hydrophobic protein
b. a large hydrophilic protein
c. sugar
d. cotton
e. NaCI

+½ D 29. Adding a base to a solution would
a. raise the pH.
b. lower the pH.
c. decrease [H+].
d. do both a and c.
e. do both band c.

+½ D 30. A hydration shell is most likely to form around
a. an ion.
b. a fat.
c. a sugar.
d. both a and c.
e. both band c.

+½ E 31. The following are the pH values for each item: cola-2; orange juice-3; beer-4; coffee-5; human blood 7.4. Which of these liquids has the *highest* molar concentration of OH-?
a. cola
b. orange juice
c. beer
d. coffee
e. human blood

+½ B 32. Comparing the [H+] of orange juice and coffee, the [H+] of
a. orange juice is 10 times higher.
b. orange juice is 100 times higher.
c. orange juice is 1,000 times higher.
d. coffee is 2 times higher.
e. coffee is 100 times higher.

+½ E 33. The ability of water molecules to form hydrogen bonds accounts for water's
a. high specific heat.
b. evaporative cooling.
c. high heat of vaporization.
d. cohesiveness and surface tension.
e. All of the above result from water's hydrogen bonding capacity.